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The Spatial Analysis of Agricultural Investment Systems in Eastern Iraq

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Abstract: The agricultural system is a process of classifying agricultural phenomena that share natural and human facts within spatial units represented by administrative units, here represented by districts representing the study area in Eastern Iraq. Standardized grade maps show the spatial distribution nature of agricultural investment and land ownership systems, which depend on their proximity to the mean of the different areas of the study districts and their standard deviation. This is shown on a map displaying the degree of distance and proximity from the zero value in either positive or negative direction. The principal component analysis method is then employed to measure the characteristics of agricultural investment in the study area using a factor branch matrix, which revealed five agricultural structure factors explaining the total variance of the variables. The study concludes with findings.

Keywords: Agricultural investment, Standardized grade, Factor analysis.

Intrudection:

The research problem lies in the clear spatial variation in agricultural investment systems, which do not appear homogeneously in the study area for the year 2022. The research hypothesis suggests that the components of agricultural investment systems do not exhibit a single degree of correlation but vary in their degree of correlation, reflecting diverse and varied agricultural structures.

The study area extends across the administrative boundaries of the southeastern provinces of Iraq, namely Basra, Maysan, and Wasit, represented by the eastern districts, including those bordering the Islamic Republic of Iran. This covers a total of 12 districts, as shown in Table (1), with an area of 26,434 square kilometers, constituting 6.08% of Iraq's total area of 434,128 square kilometers. Geographically, the area spans longitudinally from 45.30 to 48.20 and latitudinally from 30.00 to 33.30 east, holding significant importance as it acts as a link between the mountainous region of the Zagros Mountains and the alluvial plain region. The study area is bordered to the east by Iran, to the north by Diyala province, and to the west by a collection of districts within the study area's provinces .

Objective.

The study aims to measure the spatial variation of land investment in agricultural crops using quantitative statistical techniques, leading to an understanding of the structures and patterns of agricultural investment in the study area through quantitative methods such as standardized grades and factor analysis. This highlight interconnected spatial relationships to reach research conclusions.

Methodology

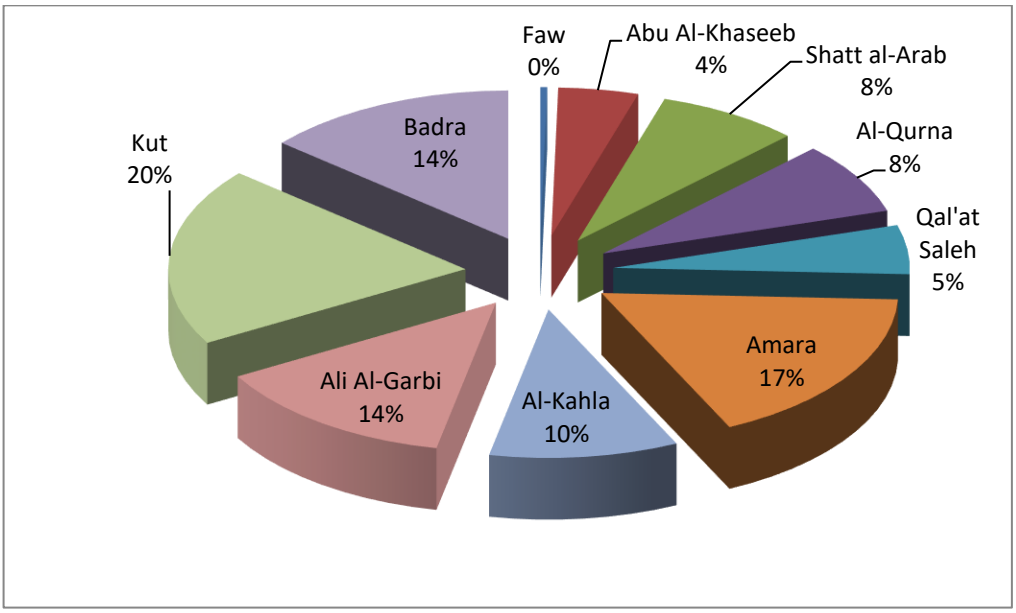
Any scientific study must adhere to a specific methodological approach, the importance of which lies in understanding the study's results and saving time for researchers. Here, a quantitative-analytical method was adopted, utilizing both quantitative and cartographic techniques. The statistical software SPSS played a significant role in processing this data, while ArcGIS 10.5 was used for mapping the research.

Table (1): Administrative Units and Their Areas in Eastern Iraq for the Year 2022.

	District	Governorate	Area km2
1	Faw	Basra	98
2	Abu Al-Khaseeb	Basra	1152
3	Shatt al-Arab	Basra	2055
4	Al-Qurna	Basra	2073
5	Qal'at Saleh	Maysan	1411
6	Amara	Maysan	4557
7	Al-Kahla	Maysan	2717
8	Ali Al-Garbi	Maysan	3577
9	Kut	Wasit	5144
10	Badra	Wasit	3650
Total			26434

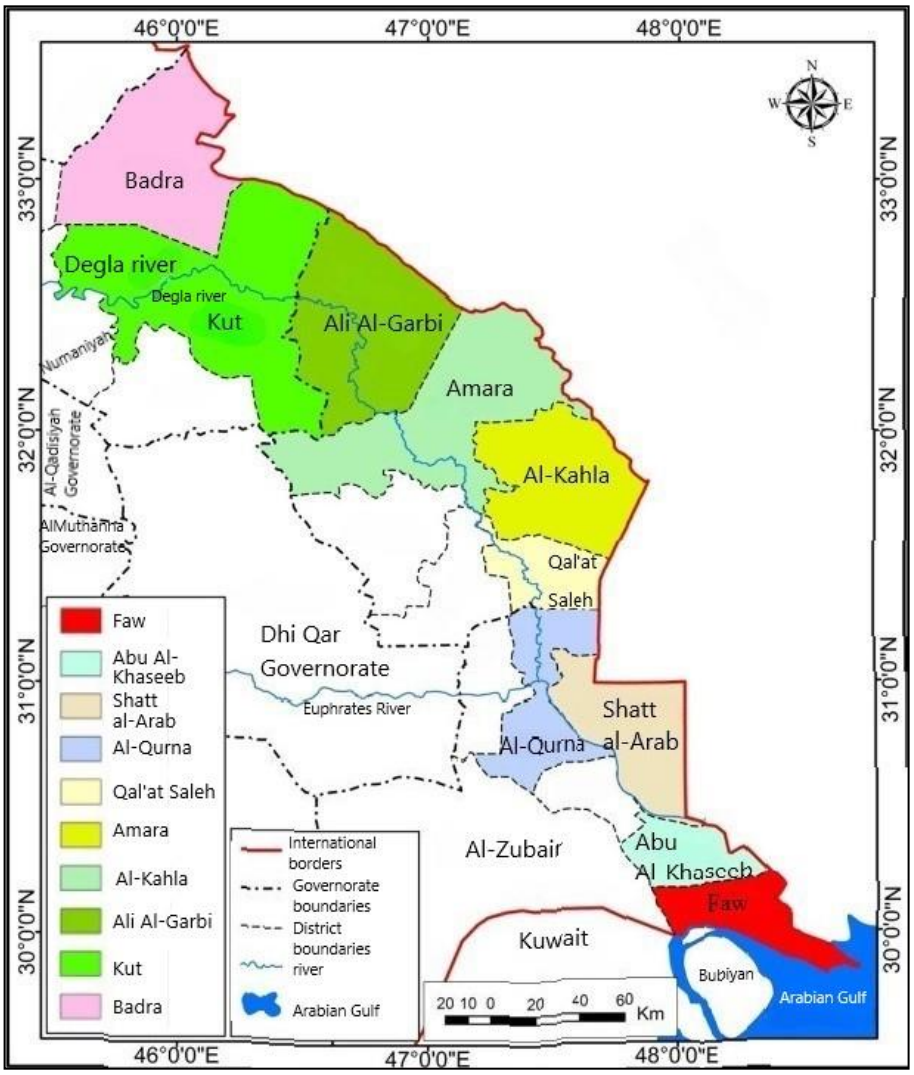
Source: *Republic of Iraq, Ministry of Planning and Development Cooperation, Central Agency for Statistics and Information* Information Technology. Statistical Yearbook for the Year 2021, p.6, Table No.(1.1) .

Figure (1): Administrative Units and their Areas in Eastern Iraq for The Year 2022.



Source: *Compiled by the researcher based on Table*.

Map (1) : The administrative division of the study area.



Source: *The researcher using ArcGIS 10.8 software.*

Concepts and Terminology.

Agricultural investment:

It is defined as a field of human activities at varying degrees, reflecting the land allocated for the production of various crops and animal types. It often expresses this relationship with agricultural investment. Our experimental methodology on the techniques of co-integration between investment and economic growth (Abdelhafidh, 2019, 144).

Spatial structure :

It means the spatial extension of the visible geographical phenomenon, that is, the visible form of the structures accomplished by man, that is, their appearance, which is usually called morphology (Abdelhafidh, 2019, 144). here it is the agricultural areas and their spatial extension that are controlled by a group of natural and human factors (Aseel Mahdi Malik, Manaf Muhammad Zarzour, 2022., p. 44).

Standardized score (Z-Score)

A statistical term that expresses the relationship of a particular value with the meaning of a set of values. The score can be positive, indicating that the value is higher than the mean, or negative, indicating that it is lower than the mean. If the score is zero, it means that the value is equal to the mean.

Factor analysis.

Factor analysis is a statistical method used to describe the variation among observed, correlated variables in terms of a few underlying variables called factors. It's possible that differences in six observable variables primarily reflect variations in two unobservable (latent) variables. Factor analysis seeks these common variations in response to unobservable latent variables (Bartholomew, D.J.& Steele, F. & Galbraith, J. &Moustaki, I. 2008).

Agricultural ownership

Agricultural tenure has become the subject of everyone's attention, linguists defined it as: whoever joins something to himself from money or otherwise, he has acquired a possession, it is said that he possessed money if he acquired it for himself, while economists mean agricultural tenure by placing hands on the land and exercising actual public authority over it by an individual in his capacity as a holder or owner of a right in kind over it (Abdul Khaliq Muhammad Majdi, 1977, p. 163), but the Food and Agriculture Organization of the International defines agricultural tenure as an area of land used wholly or partially for agricultural production purposes and managed Its technical affairs as an independent production unit by one person alone.

Spatial analysis of agricultural crops in Eastern Iraq

The investment and cultivation of barley show, according to Appendix (1), the absolute importance of grain and vegetable crops in the study area for the year 2022. Al-Ali Al-Gharbi District recorded the highest absolute importance, reaching 56,898 dunams, constituting 53.7% of the total cultivated area in the study area. Conversely, Al-Faw District showed the lowest absolute importance, reaching only 0.11%, indicating a decline in the cultivation of strategic crops, including barley, in this district. Figure (2) illustrates the deviation of absolute values of barley areas from their arithmetic mean, showing that Al-Ali Al-Gharbi and Al-Amarah districts have the highest positive deviation, while Al-Faw, Al-Qurnah, and Abu Al-Khasib districts have the lowest negative deviation .

As for the wheat crop, it is one of the main food grain crops, and its nutritional value comes from its high content of starch and protein, containing 70% starch and 15% protein. According to Appendix (1), Al-Kut District recorded the highest absolute importance, reaching 243,165 dunams, constituting 48.3% of the total cultivated area in the study area, while Al-Faw District showed the lowest absolute importance, reaching only 0.08%.

This confirms that this district is experiencing a decline in the cultivation of strategic crops, including wheat. Figure (3) illustrates the deviation of absolute values of wheat areas from their arithmetic mean, showing that Al-Kut and Al-Ali Al-Gharbi districts have the highest positive deviation, while Abu Al-Khasib and Al-Kahla districts have the lowest negative deviation. As for the yellow corn crop, Al-Amarah District recorded the highest absolute importance, reaching 18,974 dunams, constituting 36.7% of the total cultivated area in the study area, while Al-Faw District showed the lowest absolute importance, reaching only 0.05%. This confirms that this district is experiencing a decline in the cultivation of strategic crops, including yellow corn.

Figure (4) illustrates the deviation of absolute values of yellow corn areas from their arithmetic mean, showing that Al-Amarah and Al-Kut districts have the highest positive deviation, while Al-Faw, Abu Al-Khasib, and Shatt Al-Arab districts have the lowest negative deviation .

The highest absolute importance in vegetable cultivation reached 5,987 dunams, constituting 29.8% in Al-Kut District of the total cultivated area in the study area, while Al-Faw District showed the lowest cultivation with only 11 dunams, constituting 0.05%. This confirms that this district is experiencing a decline in vegetable cultivation. Figure (5) shows the spatial variation of standardized grades of vegetable crops in the study area.

Table (2): Standardized Grades of Agricultural Crops in Eastern Iraq for the Year 2022.

District	Wheat	Barley	Palm	Industrial crops	Fodder	Vegetable	Yellow Corn
Faw	-	0.61-	-0.99	0.70-	-	0.99-	0.80-
Abu Al-Khaseeb	0.68-	0.59-	1.9	0.70-	-	0.98-	0.79-
Shatt al-Arab	0.44-	0.57-	0.84	0.73-	-0.73	0.87-	0.77-
Al-Qurna	0.40-	0.60-	0.42	0.56-	-0.65	0.23-	0.73-
Qal'at Saleh	0.13-	0.58-	-0.89	0.62-	-0.07	0.82	0.17
Amara	0.01-	0.23	-0.09	0.41	0.26	0.26	2.15
Al-Kahla	-0.65	0.13	-0.64	1.34	0.07	0.94	0.09
Ali Al-Garbi	0.52	2.67	-0.08	0.06	-0.6	-0.12	0.44
Kut	2.63	0.11-	0.82	2.09	2.3	1.98	1.02
Badra	0.12-	0.04	-1.28	0.56-	-0.58	-0.81	0.75-
Arithmetic mean	50293	10582	378676	2338	954	20077	5171
standard deviation	73166	17324	255850	3160	1157	2010	6390

Source: *Compiled by the researcher based on Appendix (1) using SPSS 20 software.*

The investment of land in industrial crop cultivation is evident from Appendix (1), where Al-Kut District recorded the highest absolute importance, reaching 8,968 dunams, constituting 38.3% of the total cultivated area in the study area, while Al-Faw District showed the lowest importance, reaching only 0.03%. Figure (6) illustrates the spatial variation of standardized grades of industrial crops in the study area, showing that the farthest rank in the negative direction includes Abu Al-Khasib, Shatt Al-Arab, Al-Qurnah, and Qal'at Saleh, indicating a decline in the value of the cultivated area of industrial crops.

As for forage crops, Al-Kut District came with the highest absolute importance, reaching 3,610 dunams, constituting 47.3% of the total cultivated area in the study area, while Shatt Al-Arab District showed the lowest absolute importance, reaching only 1.37%. This confirms that this district is experiencing a decline in the cultivation of industrial crops. Figure (7) illustrates the spatial variation of standardized grades of forage crops in the study area, showing the deviation of absolute values of forage areas from their arithmetic mean. Al-Kut and Al-Amarah districts exhibit the highest positive deviation, while the rest of the districts show the lowest negative deviation. As for investment in date palm cultivation, it shows the deviation of absolute values from their arithmetic mean. Abu Al-Khasib, Al-Qurnah, and Shatt Al-Arab districts exhibit the highest positive deviation, while Badrah district exhibits the lowest negative deviation, as shown in Figure.(8)

Spatial Analysis of Agricultural Land Ownership in Eastern Iraq

Investment in agricultural land ownership according to the crop type - vegetative production is evident from Table (3) showing the z-scores for agricultural land ownership in southeastern Iraq for the year 2022 and Figure (9). Al-Amarah and Al-Kut districts recorded the highest positive z-scores, while Al-Faw district had the highest negative z-scores at (-0.91), indicating a decline in this type of ownership in the latter. Figure (9) illustrates the spatial variation of z-scores for agricultural land ownership according to the crop type - vegetative production in the study area. On the other hand, investment in agricultural land ownership according to the mixed production type is reflected in Table (3) showing the z-scores for agricultonal land ownership and Figure (10). Al-Amarah and Al-Kut districts recorded the highest positive z-scores, while Al-Faw

district had the highest negative z-scores at (-1.05), indicating a decline in this type of ownership in the latter. Furthermore, investment in agricultural land ownership according to the leased ownership system is reflected in Table (3) showing the z-scores for agricultural land ownership. Abu Al-Khasib district recorded the highest positive z-scores, while Al-Faw and Badrah districts had the highest negative z-scores, indicating a decline in this type of ownership in the latter. Figure (11) illustrates the spatial variation of z-scores for agricultural land ownership according to the ownership system in the study area. Investment in agricultural land ownership according to the leased ownership system shows that the z-scores for this type of ownership in eastern Iraq for the year 2022 indicate that Al-Kut and Al-Amarah districts recorded the highest positive z-scores, while Al-Faw and Al-Kahla districts had the highest negative z-scores .

Investment in agricultural land ownership under the system of managed tenancy is evident from Table (3) showing the z-scores for agricultural land ownership in eastern Iraq for the year 2021. Al-Qurnah district recorded the highest positive z-scores, being the only one to register this type of ownership, while the rest of the districts recorded the highest negative z-scores. Figure (12) illustrates the spatial variation of z-scores for agricultural land ownership according to the ownership system of managed tenancy in the study area.

Investment in agricultural land ownership according to the irrigation method shows from Table (3) the z-scores for agricultural land ownership. This is depicted in Figure (14), where Al-Kut, Abu Al-Khasib, and Badrah districts recorded the highest positive z-scores, while the rest of the districts recorded the highest negative z-scores. Figure (14) illustrates the spatial variation of z-scores for agricultural land ownership according to the irrigation method in the study area. Similarly, investment in agricultural land ownership according to the irrigation method of irrigation agency is evident from Table (3) showing the z-scores for agricultural land ownership in southeastern Iraq for the year 2022 and Figure (15). Al-Kut and Al-Amara districts recorded the highest positive z-scores, while Al-Faw and Badrah recorded the highest negative z-scores. Figure (15) illustrates the spatial variation of z-scores for agricultural land ownership according to the irrigation method of irrigation agency in the study area.

Table (3): Z-scores for agricultural land ownership system in southeastern Iraq for the year 2022

District	irrigation method, immersion	Tenure system manages Trespassing	Tenure system - Rental	Tenure system - owned.	mixed production	plant production.	irrigation method using tools
Faw	0.26-	0.20-	1.19-	1.14-	1.05-	0.91-	1.55-
Abu Al-Khaseeb	1.34	0.47-	0.22-	2.02	0.92-	1.85	0.69
Shatt al-Arab	0.88-	0.33-	0.22-	0.22	0.95-	0.60	0.25
Al-Qurna	0.38-	2.79	0.03	0.59-	0.72-	1.18	0.80
Qal'at Saleh	0.31-	0.41-	0.01-	0.46-	0.42	0.69-	0.34-
Amara	0.59-	0.16	1.24	0.59	1.65	0.06-	1.26
Al-Kahla	0.85-	0.44-	0.82-	0.35-	0.24	0.92-	0.52-
Ali Al-Garbi	0.91-	0.34-	0.52-	0.10-	0.24	0.92	0.16-
Kut	1.51	0.24-	2.17	0.90	1.53	0.55	1.07
Badra	1.36	0.50-	0.42-	0.83-	0.44-	0.69-	1.14-
Arithmetic average	355	215	741	1301	861		1872
standard deviation	377	433	600	775	759	1127	1177

Source: *Derived from the researcher's work based on Annex (2) using SPSS 20 software.*

Factor Analysis of Agricultural Investment Systems in Eastern Iraq

The basic component technique (factor analysis) consists of two main steps, the first of which reveals (Paul Horst, 1968, P.15). The relationship of each of the variables used by the analysis to a hypothetical factor. The values of these relationships (variable ramifications) are known as the Factor Loadings, and these values represent the components of structures. The number of these structures depends on the number of hypothetical factors that are important in the analysis and this importance is determined by two basic criteria: the ratio of the variance of the data table contained in the factor as measured by the sum of Squares of factor ramifications commonly known as eigenvalues (Eigen Value).

The second criterion consists of a minimum number of variables (components) that are significant within the structure. This number must not be less than three, and the significance of the variable within the structure is determined by its correlation (saturation) with the hypothetical factor, which should not fall below a certain threshold value.

Despite the variation in the threshold value depending on the nature and purpose of the study, a saturation value of 40% can be considered an appropriate threshold for the study (Keys.C. L & Mccracken.K.W. J,1981, P.12.), based on this basis, the components of the structure are determined by the variables whose saturation value exceeds this cutoff. Table (4), presented by the factor analysis of the variables in this study, indicates that three of the factors account for 81% of the variance in the data table. This represents more than two-thirds of the table's variance, indicating the significance of the relationships represented by this proportion .

The results of the factor analysis of agricultural crops and agricultural tenure variables revealed the presence of three influential factors according to Table (4). A factor is considered influential when the loading value is greater than or equal to .(0.40±)

Factor 1: The strength of this factor is (4.81), and its influence accounts for (43.76%) of the total variance. It represents the impact of cereal crops and irrigated land tenure according to the method of irrigation by channels. This confirms the decline of other tenures in this system. The strong influence of these variables results from their presence in the most prevalent cereal crops in the study area .

Factor 2: The strength of this factor is (2.56), and it influences approximately (23.28%) of the total variance. It represents the positive impact of vegetable crop farming systems, orchards with owned tenures, and plant-based and mixed tenures .

Factor 3: Its strength is (1.583), and it influences approximately (14.41%) of the total variance. It represents the simple positive impact of vegetable crop farming systems with diverse tenures based on the scores of Factors 3 in East Iraq .

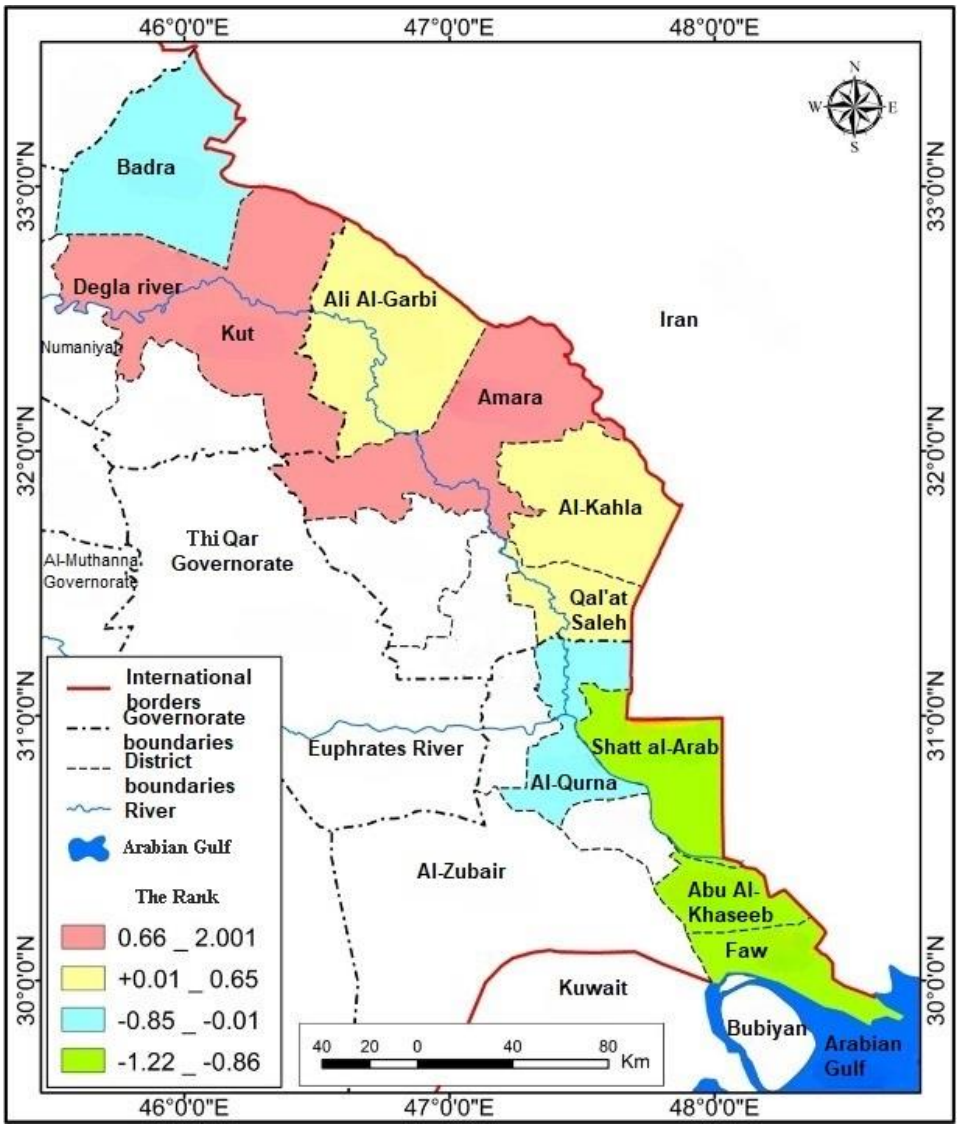
Revealing the structure of agricultural crops and land tenure in the study area implies providing generalizations that express these structures. However, the spatial characteristic of geography requires understanding its spatial appearance and the spatial variation it entails. This was achieved for us by the scores of each of these structures (factors), i.e., their degree of occurrence in each of the samples taken from these areas in the study region. This was accomplished in the second step of the principal component analysis, where several factors were identified to represent the branching factors. Each of these factors includes scores that measure the presence of each of the structures revealed by the branching factors (Table 4). The disclosure of the degree of existence of each of these structures, as measured by factor scores, enabled the revelation of their spatial variation by representing them on the map after statistical classification .

Map (2) illustrates the spatial analysis of the irrigation-based cereal cropping system based on the scores of the first factor in East Iraq for the year 2022. This system exhibits spatial variation into four ranks, two of which appear positively and two negatively. The rank (0.66-2.001) is spatially evident in the central area of the study region in Al-Amarah and Al-Kut districts. As for the rank (+0.01- +0.65), which is closest to zero, it encompassed a large spatial extension in the

central part of the study area, including Qal'at Salih and Al-Kahla districts forming a connected spatial pattern, while Al-Ghali Al-Gharbi appears in the northern part of the study area. However, other parts of the study region exhibited spatial variation within the ranks that appeared negatively. The category (-1.22- -0.86), which is the farthest from zero, implies that it does not possess a variation percentage for the represented factor appearing as a range in the southern part of the study area, encompassing Al-Faw, Abu Al-Khasib, and Shatt Al-Arab districts.

As for the second factor, as shown in Map (3), the spatial analysis of the vegetable and orchard cropping system based on the scores of the second factor in East Iraq for the year 2022 reveals spatial variation. The rank (0.01-0.87) appeared spatially in an arch shape in the central to northern part of the study area, encompassing Al-Amarah, Al-Kut, and Shatt Al-Arab districts. As for the rank (0.88-2.10), it included Abu Al-Khasib district. However, the rest of the study area exhibited spatial variation within the ranks that appeared negatively. The category (-0.67- -1.32) represents the farthest rank from zero, indicating significant declines in the components of this system. It included only Al-Faw, Al-Kahla, and Badrah districts, while the remaining districts of the study area fell within the range of -0.01- -0.68 .

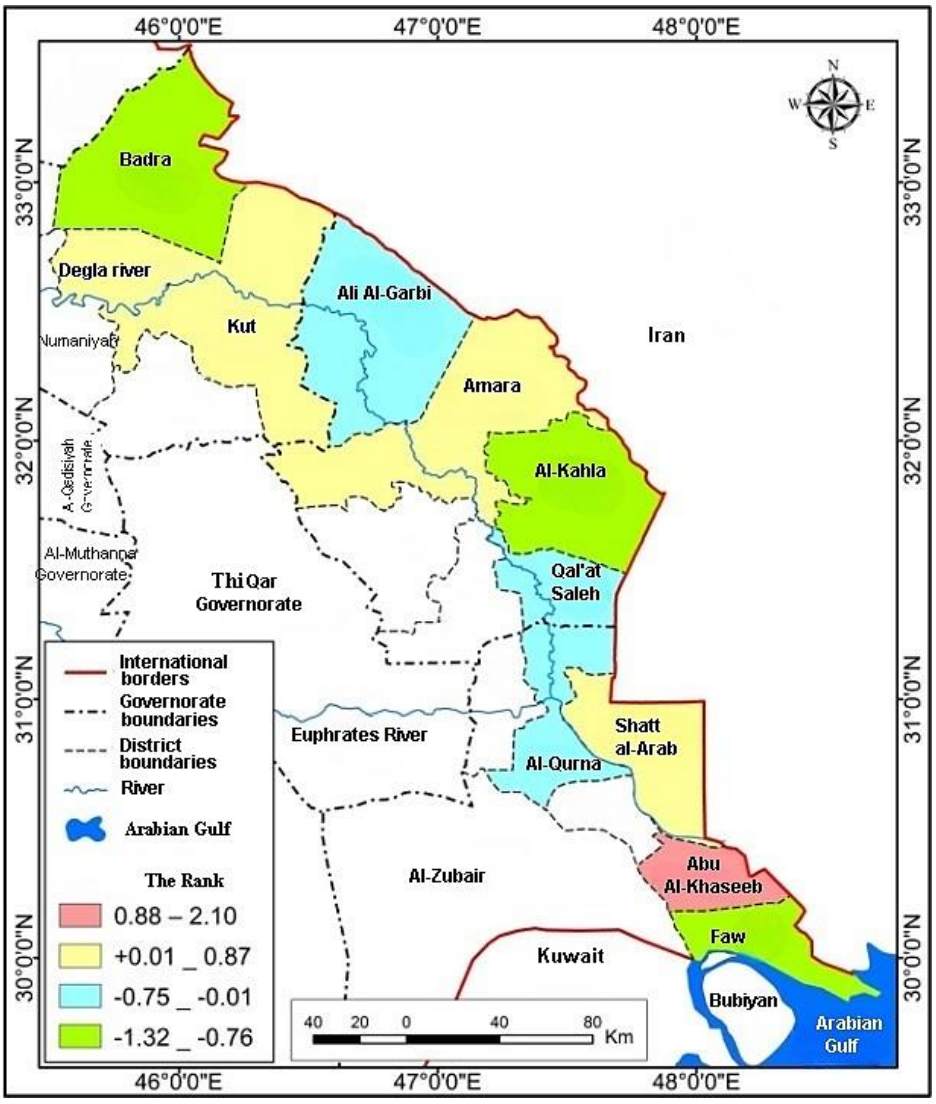
Map (2): Spatial Analysis of Irrigated Grain Crops Cropping System in East Iraq for the year 2022.



Source: *Based on the researcher's work using Table (6) and SPSS software.*

The third factor is evident from Map (4), the spatial analysis of vegetable cultivation systems with various types of land ownership based on the third factor scores in East Iraq for the year 2022. This system shows spatial variation, with the range (-0.01- -0.68) being the most prevalent spatially, encompassing districts across the study area and spreading spatially in two ranges, one extending to the south and the other to the north. The farthest negative rank (-1.30 - -0.67) was only included in the northern part of the study area, specifically in Al-Ghraib district. As for the range (0.92- 2.07), it extended only in the Qurna district. The factor's branching appeared farther from zero, as demonstrated by the factor analysis technique.

Map (3) displays the spatial analysis of vegetable cultivation and orchard systems with privately owned plant-based, and mixed ownership based on the second factor scores in East Iraq for the year 2022.



Source: *From the researcher's work based on Table (6) and SPSS software.*

Table (4): Analysis of Variance for Variables in the Study Area

Component Pollutants	Initial Eigenvalues			Extraction Sums of squared loading		
	Total Eigun Value	% of Variance	Cumulative e%	Total Eigun Value	% of variance	Cumulative e%
Barley	5.19	47.24	47.24	4.81	43.70	43.76
Wheat	2.61	23.75	70.99	2.56	23.23	67.05
yellow corn	115	10.40	81.46	1.58	14.41	81.48
Industrial	0.884	8.06	89.63			

crops				
Vegetables	0.553	5.44	94.97	
Palm	0.600	2.47	97.44	
Vegetarian possession	0.387	0.23	97.67	
Mixed tenure	0.253	0.89	98.56	
Owned	0.300	0.33	98.89	
Rented	0.187	0.53	98.76	
Surface irrigation	0.04	0.52	99.52	
Irrigation with tools	0.07	0.48	100.000	

Source: *Derived from the researcher's work, relying on Appendices (1) and (2) and SPSS software.*

Table (5): Factor Loadings in the Study Area

	Component		
third factor	second factor	first factor	Agricultural produce
-0.17	0.22	0.94	barley
-0.03	-0.40	0.90	Wheat
-0.20	0.03	0.85	yellow corn
-0.23	0.09	0.85	Industrial crops
-0.44	0.66	0.80	Vegetables
0.27	0.48	0.44	Palm
0.11	0.94	-0.22	Vegetarian possession
0.03	0.87	-0.15	Mixed tenure
0.43	0.75	0.48	Owned
0.40	0.66	0.11	Rented
0.91	0.05	0.13	Surface irrigation
-0.53	0.03	0.66	Irrigation with tools

Source: *The researcher based on Appendices (1) and (2) and SPSS software. Table .(6)*

Conclusions:

1. Geography studies the distributions and spatial patterns on the Earth's surface, from which we describe patterns and analyze the processes that have created them.
2. The standard scores for agricultural crop area varied in the study area, showing deviations from the zero value in either the negative or positive direction.
3. Agricultural holdings represented a spatial extent that varied from one type to another, as shown by the graphical representations of their standard scores, which differed from one type to another.
4. Factor analysis maps serve as a connection between statistical methods as a technical means of analysis and inference, and as a fundamental pillar of geography.
5. Factor analysis aims to identify a set of factors responsible for generating differences in a large set of response variables.
6. The first system showed the greatest clarity within the range (+0.01 to +0.65), appearing in the districts of Qal'at Salah, Al-Khalis, and Ali Al-Sharqi, and appeared spatially in the central north of the study area.
7. The first system comprises four variables of total variance in the matrix of agricultural investment value standards, accounting for 43.76% of the total variance.

8. The second system, represented by the second factor in the matrix of basic components, consists of three factors, accounting for 23.28% of the total variance in the agricultural investment matrix.
9. The second system appeared more prominently in the ranks closest to the zero value in both the negative and positive directions, with its spatial representation extending into the central study area and southwards.
10. The third system, represented by the third factor in the matrix of basic components, consists of three factors, accounting for 14.41% of the total variance in the agricultural investment matrix.

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